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Live celloidosome structures based on the assembly of individual cells by colloid interactions

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Abstract

A new class of colloid structures, celloidosomes, has been developed which represent hollow microcapsules whose membranes consist of a single monolayer of living cells. Two routes for producing these structures were designed based on templating of: (i) air bubbles and (ii) anisotropic microcrystals of calcium carbonate with living cells, which allowed us to fabricate celloidosomes of spherical, rhombohedral and needle-like morphologies. Air microbubbles were templated by yeast cells coated with poly(allylamine hydrochloride) (PAH), then coated with carboxymethylcellulose and rehydrated resulting in the formation of spherical multicellular structures. Similarly, calcium carbonate microcrystals of anisotropic shapes were coated with several consecutive layers of oppositely charged polyelectrolytes to obtain a positive surface charge which was used to immobilise yeast cells coated with anionic polyelectrolyte of their surfaces. After dissolving of sacrificial cores, hollow multicellular structures were obtained. The viability of the cells in the produced structures was confirmed by using fluorescein diacetate. In order to optimize the separation of celloidosomes from free cells magnetic nanoparticles were immobilised onto the surface of templates prior to the cells deposition, which greatly facilitated the separation using a permanent magnet. Two alternative approaches were developed to form celloidosome structures using magnetically functionalised core-shell microparticles which resulted in the formation of celloidosomes with needle-like and cubic-like geometries which follows the original morphology of the calcium carbonate microcrystals. Our methods for fabrication of celloidosomes may found applications in the development of novel symbiotic bio-structures, artificial multicellular organisms and in tissue engineering. The unusual structure of celloidosomes resembles the primitive forms of multicellular species, like Volvox, and other algae and could be regarded as one possible mechanism of the evolutionary development of multicellularity.

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